



Europäisches Patentamt
European Patent Office
Office européen des brevets



(11) Publication number: **0 447 978 B1**

EUROPEAN PATENT SPECIFICATION

(45) Date of publication of patent specification :
19.07.95 Bulletin 95/29

(51) Int. Cl.⁶: **G01S 5/14**

(21) Application number: 91104025.1

(22) Date of filing: 15.03.91

(54) GPS receiver.

(30) Priority: 20.03.90 JP 68302/90

(43) Date of publication of application :
25.09.91 Bulletin 91/39

(45) Publication of the grant of the patent :
19.07.95 Bulletin 95/29

(84) Designated Contracting States :
DE FR GB

(56) References cited :
EP-A- 0 353 849
US-A- 4 426 712
US-A- 4 445 118
PATENT ABSTRACTS OF JAPAN vol. 13, no.
306 (P-897) 13 July 1989 & JP-A-1 079 679
(TOYOTA CENTRAL RES & DEV LAB, INC.) 24
March 1989

(73) Proprietor: PIONEER ELECTRONIC
CORPORATION
No. 4-1, Meguro 1-chome
Meguro-ku Tokyo 153 (JP)

(72) Inventor: Ando, Hitoshi, Pioneer Electronic
Corporation
Kawagoe-kojo, 25-1,
Aza Nishimachi,
Oaza Yamada
Kawagoe-shi, Saitama, 350 (JP)
Inventor: Shimakata, Masashi, Pioneer
Electronic Corporation
Kawagoe-kojo, 25-1,
Aza Nishimachi,
Oaza Yamada
Kawagoe-shi, Saitama, 350 (JP)
Inventor: Tsuchiya, Toshiaki, Pioneer
Electronic Corporation
Kawagoe-kojo, 25-1,
Aza Nishimachi,
Oaza Yamada
Kawagoe-shi, Saitama, 350 (JP)

(74) Representative: Reinhard, Skuhra, Weise
Postfach 44 01 51
D-80750 München (DE)

EP 0 447 978 B1

Note: Within nine months from the publication of the mention of the grant of the European patent, any person may give notice to the European Patent Office of opposition to the European patent granted. Notice of opposition shall be filed in a written reasoned statement. It shall not be deemed to have been filed until the opposition fee has been paid (Art. 99(1) European patent convention).

Descripti n

1. Field of the Invention

This invention relates to radio navigation receivers, and more particularly to a radio receiver adopted for use with the Global positioning System (GPS) navigation system wherein a present position of the user station is determined based on respective ephemeris data received from a plurality of satellites.

2. Description of the Prior Art

In known prior art GPS receivers (for example EP-A-0 353 849), a present position of the user station is calculated based on ephemeris data obtained from the GPS satellites by receiving satellite signals as it is well known in the art.

In the prior art GPS receiver of this type, to perform the positioning with updated ephemeris data of GPS satellites, if the power supply has turned off, each ephemeris data obtained from the GPS satellites has been lost at all times.

The operation of such prior art GPS receiver will be described with reference to a flowchart shown in Fig. 1, wherein ST1 - ST4 designate operational steps to be performed by the GPS receiver.

Upon initiation of the GPS receiver, it is checked whether or not respective GPS satellite is acquired by the GPS receiver (step ST1). If it is, respective ephemeris data is collected (step ST2).

It is then checked whether or not the collection of respective ephemeris data from the GPS satellites has finished (step ST3). If it has, the program goes to a position calculating routine wherein the position calculation of the user station is initiated based on the collected ephemeris data (step ST4), whereas if it has not, step ST4 is repeated.

Accordingly, the present position of the user station can be calculated based on the collected ephemeris data. However, in accordance with the prior art GPS receiver, it has been required to collect the ephemeris data once again even if the power has turned off for such a short period of time. This in turn results in a problem for delaying the initiation of position calculation, since it takes a considerable time for the GPS receiver to re-collect the usable ephemeris data.

It is therefore an object of this invention to eliminate the problem encountered in the prior art GPS receiver and to provide a GPS receiver capable of initiating position calculation with no delay based on the ephemeris data being stored when the power has turned off, if the power is turned on again within a predetermined period of time after the power turn off.

SUMMARY OF THE INVENTION

The present invention provides a GPS receiver

comprising a power supplying status detector for deriving a power-on signal therefrom by detecting a power-on status of the GPS receiver and that a power-off signal therefrom by detecting a power-off status of the GPS receiver, a clock section for measuring time, a memory control section for controlling a non-volatile memory, upon receiving the power-off signal from the power supplying status detector, to store a time measured at the clock section when the power is turned off or a time when the last ephemeris data is obtained, and respective ephemeris data obtained in the last place, and a position calculating circuitry for calculating the position of the user station upon receiving the power-on signal, wherein a time duration is calculated based on the time measured at the clock section and the time stored in the nonvolatile memory, and thereby if it is determined that the measured time duration is shorter than a predetermined period of time, the positioning is performed based on the respective ephemeris data stored in the nonvolatile memory, whereas if it is determined that the measured time duration is at or longer than the predetermined period of time, the positioning is performed based on respective ephemeris data newly collected from the respective GPS satellites.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a flowchart illustrating operational steps to be performed by a prior art GPS receiver; Fig. 2 is a block diagram of a GPS receiver embodying the present invention; and Fig. 3 is a flowchart illustrating operational steps to be performed by the GPS receiver of Fig. 2.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Fig. 2 is a block diagram showing the architecture of the GPS receiver of the present invention. A block 1 designates a microprocessor unit (MPU) to implement required various functions by making use of a random memory (RAM) 3 as a work area in accordance with a system program stored in a read-only memory (ROM) 2.

The GPS receiver is operated under the control of a microcomputer consisting of the MPU 1 through RAM 3.

A block 4 designates a receiver/demodulator section for deriving clock data, ephemeris data, almanac data and the like therefrom by receiving and demodulating satellite signals from GPS satellites, as it is well known in the art.

A block 5 designates a power supplying status detecting section for outputting a power-on signal by detecting the power-on of the GPS receiver or a power-off signal by detecting the power-off of the GPS receiver. The power supplying status detecting section

5 discriminates the power supplying status as power-on when a power source voltage increases at or above a predetermined voltage while power-off when the power source voltage decreases less than the predetermined voltage.

Further in Fig. 2, a block 6 designates a clock section (a digital clock section), a block 7 designates a rewritable nonvolatile memory for storing the time when the last ephemeris data is obtained before turning off the power and respective ephemeris data at that time.

A block 8 designates an operating unit provided with ten keys, function keys, a touch panel and the like for entering required inputs to the GPS receiver.

A line 9 designates a system bus being connected with the MPU 1 through the operating unit 8.

In addition to the above, there are provided several units such as an interface unit for taking out present position data from the GPS receiver and the like, however, they are not shown in the drawing.

Further the principle of the processing method and fundamental structure of the GPS receiver are well known in the art by several literatures and will not be discussed in more detail.

Now referring to Fig. 3, there is shown a flowchart for illustrating operational steps ST11 - ST18 to be implemented by the MPU and associated units of the GPS receiver.

In operation, upon initiation of the GPS receiver, the MPU performs a first step ST11 of measuring a time duration t from time data stored in the nonvolatile memory 7 (the time when the last ephemeris data is obtained in the previous operation) to a time measured at the clock section 6. It is then determined at step ST12 whether or not the time duration t is less than the predetermined period of time (for example, 120 minutes). If it is determined at step ST12 that the time duration t is more than the predetermined period of time T , it is determined at step ST13 whether or not the respective satellite is acquired. If it is, step 14 obtains respective ephemeris data from every GPS satellite in contact, whereas if it is not, step ST13 is repeated. It is then checked at step ST15 whether or not the all ephemeris data have collected. If it have not, step ST15 is repeated, whereas if it have, the program goes to step ST16. If it is determined at step ST12 that the time duration t is less than the predetermined period of time T , the program goes to step ST16. Step ST16 constitutes a position calculating routine and calculates the position of the user station based on respective ephemeris data obtained at step ST14 or respective ephemeris data stored in the nonvolatile memory 7.

Step ST17 determines whether or not the power is turned off at the completion of every position calculation at the position calculating routine (step ST16) based on an output of the power supplying status detector 5. If it is not, the program returns to step ST16, whereas if it is, Step ST18 stores the time when

the last ephemeris data is obtained and respective ephemeris data obtained in the last place.

As described above, in accordance with this invention, since the position calculation is initiated based on the respective ephemeris data stored in the nonvolatile memory 7 without re-collecting respective ephemeris data at the time when the power supply is turned off for a short period of time, there will be no loss in time for waiting the initiation of position calculation, thus improving the operability.

As alluded to in the operational discussion, the position of the user station can be calculated expeditiously by embodying the present invention to a vehicle navigation system. It is also very convenient for a vehicle to install the GPS receiver of the present invention therein for calculating the present position with no delay after the intermission of power supply.

In the embodiment described above, it has been discussed with the operational step wherein the time to store the respective ephemeris data into the nonvolatile memory 7 is selected to be a time when the last ephemeris data is obtained, however, it should be noted that this operational step is not only limited to such implementation but to a different type of implementation such as to select the time to be a time measured at the clock section 6 when the power is turned off.

It is apparent for those skilled in the art that the power supply to the clock section 6 is maintained at all times even if the power to the GPS receiver is turned off. Accordingly, the nonvolatile memory 7 may be substituted by a conventional memory with battery back-up supported by the same power source as that of the clock section 6 in a duration of power-off.

Further in another modification, a timer in the MPU 1 may also be used for measuring time instead of providing the discrete clock section 6 described above.

It will be apparent from the foregoing description and drawings that further modification may be made without departing from the spirit and scope of the present invention. Accordingly, the present invention is not to be considered to be limited to the specific embodiment illustrated, except insofar as may be required by the following claims.

Claims

1. A GPS receiver for positioning comprising:
 - detecting means for detecting a state of power supply to derive a power-on signal therefrom when the power is turned on and that a power-off signal therefrom when the power is turned off;
 - time measuring means for measuring time;

control means for controlling a memory upon receiving the power-off signal from said detecting means to store a time measured at the time measuring means or a time when the last ephemeris data is obtained and said last obtained ephemeris data; and

calculating means for calculating a position based on ephemeris data upon receiving the power-on signal from said detecting means, wherein a time duration is calculated from the time measured at said measuring means and the time stored in the memory, and respective ephemeris data stored in the memory is used for said position calculation when the calculated time duration is shorter than a predetermined period of time while respective ephemeris data newly obtained from respective satellites is used for said position calculation when the calculated time duration is at or longer than the predetermined period of time.

2. A GPS receiver for positioning as defined in claim 1, wherein said time measuring means is a built-in clock.
3. A GPS receiver for positioning as defined in claim 1, wherein said time measuring means is a timer contained in said calculating means.
4. A GPS receiver for positioning as defined in claim 1, wherein said memory is a nonvolatile memory.
5. A GPS receiver for positioning as defined in claim 1, wherein said memory is a battery back-up memory.
6. A GPS receiver for positioning as defined in claim 1, further including operating means for entering required inputs.

Patentansprüche

1. GPS-Empfänger für Positionierung, mit einer Erfassungsvorrichtung zur Erfassung eines Spannungsversorgungszustandes, welche daraus ein Spannung-An-Signal ableitet, wenn die Spannung angeschaltet ist, und ein Spannung-Aus-Signal, wenn die Spannung ausgeschaltet ist;
einer Zeitmeßvorrichtung zur Messung der Zeit;
einer Steuervorrichtung zur Steuerung eines Speichers bei Empfang des Spannung-EIN-Signals von der Erfassungsvorrichtung zur Speicherung der Zeit, welche durch die Zeitmeßvorrichtung gemessen wurde, oder der Zeit, bei der die letzten Ephemeridendaten erhalten wurden, sowie dieser letzten erhaltenen Ephemeridenda-

ten; und

einer Berechnungsvorrichtung zur Berechnung einer Position basierend auf den Ephemeridendaten bei Empfang des Spannung-EIN-Signals von der Erfassungsvorrichtung, wobei eine Zeitdauer aus der Zeit, welche durch die Meßvorrichtung gemessen wurde, und der Zeit berechnet wird, welche in dem Speicher gespeichert ist, und wobei die jeweiligen Ephemeridendaten, welche in dem Speicher gespeichert sind, zur Positionsberechnung verwendet werden, wenn die berechnete Zeitdauer kürzer ist als eine vorbestimmte Zeitperiode, während die jeweiligen neu erhaltenen Ephemeridendaten von den jeweiligen Satelliten für die Positionsberechnung verwendet werden, wenn die berechnete Zeitdauer größer oder gleich der vorbestimmten Zeitperiode ist.

2. Empfänger nach Anspruch 1, dadurch gekennzeichnet, daß die Zeitmeßvorrichtung eine eingebaute Uhr ist.
3. Empfänger nach Anspruch 1, dadurch gekennzeichnet, daß die Zeitmeßvorrichtung ein Zeitgeber ist, welcher in der Berechnungsvorrichtung enthalten ist.
4. Empfänger nach Anspruch 1, dadurch gekennzeichnet, daß der Speicher ein nichtflüchtiger Speicher ist.
5. Empfänger nach Anspruch 1, dadurch gekennzeichnet, daß der Speicher ein durch Batterie gesicherter Speicher ist.
6. Empfänger nach Anspruch 1, dadurch gekennzeichnet, daß er ferner eine Betriebsvorrichtung enthält zur Eingabe erforderlicher Eingaben.

Revendications

1. Récepteur G.P.S. servant au positionnement, comprenant :
des moyens de détection, servant à détecter un état d'alimentation en courant en vue d'en déduire un signal d'alimentation établie, lorsque l'alimentation est établie, et un signal d'alimentation coupée lorsque l'alimentation est coupée ;
des moyens de mesure de temps, servant à mesurer le temps ;
des moyens de commande, servant à commander une mémoire à la réception du signal d'alimentation coupée provenant des moyens de détection, en vue de ranger en mémoire un temps mesuré par les moyens de mesure de temps ou un temps auquel les dernières données d'éphé-

méridés ont été obtenues et lesdites dernières données d'éphémérides obtenues ; et

des moyens de calcul servant à calculer une position sur la base de données d'éphémérides à la réception du signal d'alimentation établie, en provenance des moyens de détection, une durée étant calculée à partir du temps mesuré par lesdits moyens de mesure et du temps rangé dans la mémoire, et des données d'éphémérides respectives rangées dans la mémoire étant utilisées pour ledit calcul de position lorsque la durée calculée est plus courte qu'une période de temps préfixée, tandis que des données d'éphémérides respectives nouvellement obtenues à partir des satellites respectifs sont utilisées pour ledit calcul de position lorsque la durée calculée a la même valeur ou est plus longue que la période de temps préfixée.

2. Récepteur G.P.S. servant au positionnement selon la revendication 1, dans lequel lesdits moyens de mesure de temps consistent en une horloge encastree. 20
3. Récepteur G.P.S. servant au positionnement selon la revendication 1, dans lequel lesdits moyens de mesure de temps consistent en une horloge contenue dans lesdits moyens de calcul. 25
4. Récepteur G.P.S. servant au positionnement selon la revendication 1, dans lequel ladite mémoire est une mémoire non volatile. 30
5. Récepteur G.P.S. servant au positionnement selon la revendication 1, dans lequel ladite mémoire est une mémoire du type double sur batterie. 35
6. Récepteur G.P.S. servant au positionnement selon la revendication 1, comprenant en outre des moyens d'actionnement servant à introduire les valeurs d'entrée requises. 40

45

50

55

5

FIG. 1
PRIOR ART

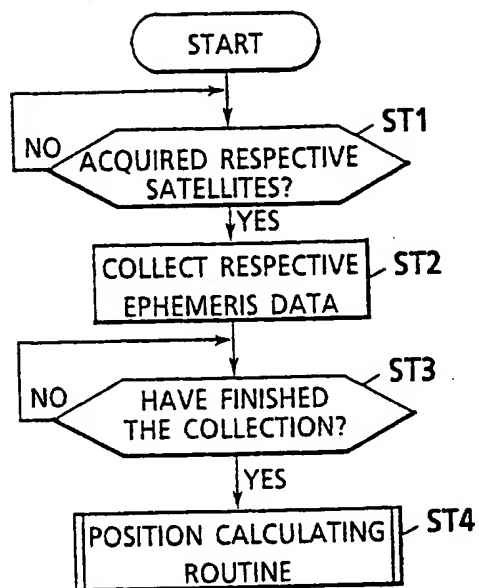


FIG. 2

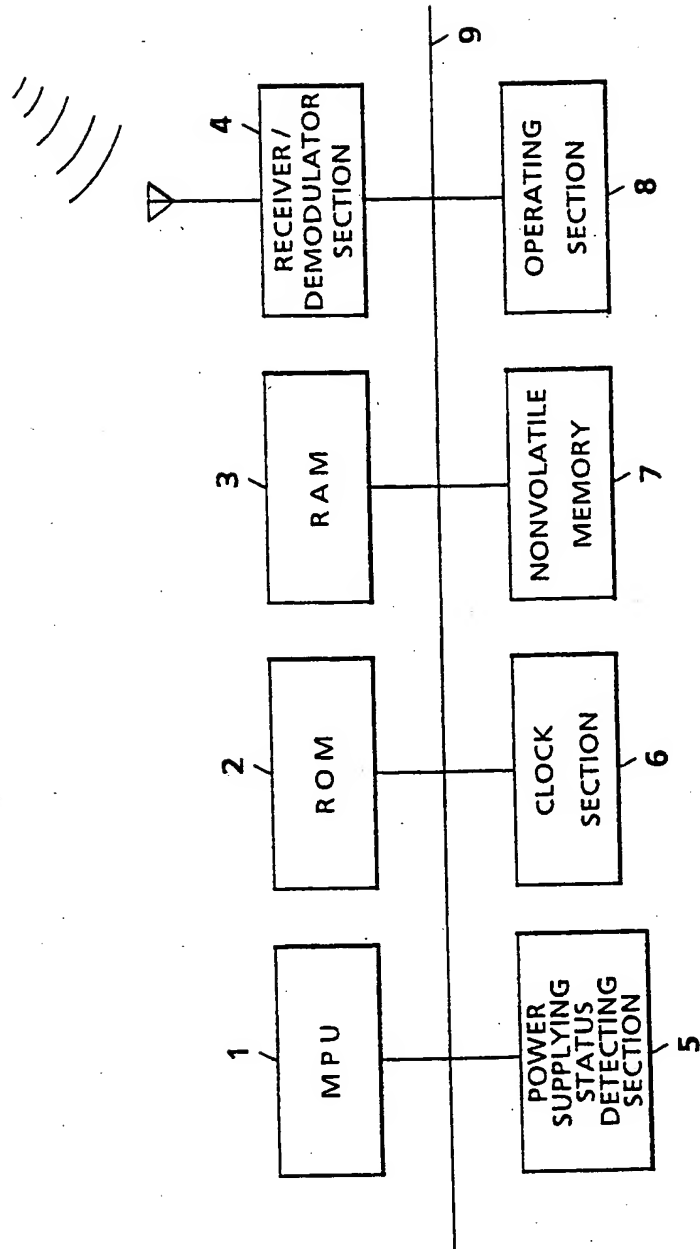


FIG. 3

